



PATENT

Attorney Docket No. 401165/SAKAI

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:

SUZUKI et al.

Art Unit: Unknown

Application No.: Unknown

Examiner: Unknown

Filed: April 25, 2001

For: PERIODIC CONTROL  
SYNCHRONOUS  
SYSTEM

**CLAIMS PENDING AFTER PRELIMINARY AMENDMENT**

1. A periodic control synchronous system for synchronizing periodic control between controllers connected in a network and devices connected to said network, wherein

each of said controllers and said devices comprises a global timer controlled through said network, and

synchronization of periodic control is performed by generating synchronous timing for periodic control using global time indicated by said global timer.

2. The periodic control synchronous system according to claim 1, wherein each of said global timers of said controllers is set by a master global timer, each of said global timers of said devices is set by a slave global timer, each of said controllers comprises a transmitting unit which transmits a periodic timing time using global time indicated by the master global timer to said devices as a period transfer packet, and

each of said devices comprises a periodic control unit which performs periodic control using the synchronous timing time of the periodic transfer packet transmitted by said transmitting unit and the global time indicated by said slave global timer.

3. The periodic control synchronous system according to claim 1, wherein each of said devices further includes,

an operation period timer which controls an operation period of said device itself;  
and

a correcting unit which corrects said operation period timer by determining the time difference between the global time indicated by said global timer of said device and the synchronous timing time indicated by said controller at the synchronous timing indicated by said operation period timer, and determines a timer correction value or a timer period correction value of said operation period timer based on the time difference.

4. The periodic control synchronous system according to claim 3, wherein said correcting unit includes,

a detecting unit which detects whether the time difference is within an allowable range, and

corrects said operation period timer based on the timer correction value or the timer period correction value when the time difference is within an allowable range, and does not correct said operation period timer when the time difference is outside of the allowable range.

5. The periodic control synchronous system according to claim 1, wherein each of said controllers further includes,

a control period timer which controls an control period of said controller itself;  
and

a correcting unit which corrects said control period timer by determining time difference between the global time indicated by said global timer of said controller and the synchronous timing time indicated by said controller at the synchronous timing indicated by said control period timer, and determines a timer correction value or timer period correction value of said control period timer based on the time difference.

6. The periodic control synchronous system according to claim 5, wherein said correcting unit includes,

a detecting unit which detects whether the time difference is within a specified allowable range, and

corrects said control period timer based on the timer correction value or the timer period correction value when the time difference is within allowable range, and does not correct said control period timer when the time difference is outside of the allowable range.

7. A periodic control synchronous system for synchronizing periodic control between controllers connected in a network and devices connected to said network, wherein

each of said controllers includes,

a first global timer controlled through said network;

a control period timer which controls a control period of periodic control;

a time stamp providing unit which provides a periodic transfer packet with a time stamp showing synchronous timing of the control period designated by said control period timer by using global time indicated by said first global timer; and

a transmitting unit which transmits the periodic transfer packet provided with the time stamp to said devices, and

each of said devices includes,

a second global timer controlled through said network; and

a periodic control unit which synchronizes an operation period of said device with the control period using the synchronous timing time of the periodic control indicated by the time stamp of the periodic transfer packet transmitted by said transmitting unit and global time indicated by said second global timer.

8. The periodic control synchronous system according to claim 7, wherein said controller comprises a latch unit which latches the global time of said first global timer, and holds the time latched,

said control period timer latches the global time of said first global timer in said latch unit at the synchronous timing of the periodic control designated by said control period timer, and

said time stamp providing unit provides the periodic transfer packet with the time stamp having the global time latched by said latch unit, offset by a portion of the control period.

9. The periodic control synchronous system according to claim 7, wherein each of said devices includes,

    an operation control period timer which controls the operation period of said device itself;

    a comparing unit which compares the synchronous timing time of the periodic control indicated by the time stamp of the periodic transfer packet transmitted by said transmitting unit and the global time indicated by said second global timer; and

    a correcting unit which corrects said operation period timer by determining time difference between the synchronous timing time of the periodic control indicated by the time stamp compared by said comparing unit and the global time indicated by said second global timer at the synchronous timing indicated by said operation period timer, and determines a timer correction value or a timer period correction value of said operation period timer based on the time difference.

10. The periodic control synchronous system according to claim 9, wherein said correcting unit includes,

    a detecting unit which detects whether the time difference is within an allowable range; and

    corrects said operation period timer based on the timer correction value or the timer period correction value when the time difference is within the allowable range, and does not correct said operation period timer when the time difference is outside of the allowable range.

11. The periodic control synchronous system according to claim 7, wherein each of said devices includes,

    an operation control period timer which controls an operation period of said device itself;

a comparing unit which compares the synchronous timing time of the periodic control indicated by the time stamp of the periodic transfer packet transmitted by said transmitting unit and the global time indicated by said second global timer; and

a correcting unit which resets said operation period timer when the global time indicated by said second global timer reaches the synchronous timing time of the periodic control indicated by the time stamp.

12. The periodic control synchronous system according to claim 11, wherein said correcting unit resets said operation period timer when reaching the synchronous timing indicated by said operation period timer before the global time indicated by said second global timer reaches the synchronous timing time of the periodic control indicated by the time stamp, and resets said operation period timer again later when the synchronous timing time of the periodic control indicated by the time stamp at least reaches the global time indicated by said second global timer.

13. The periodic control synchronous system according to claim 11, wherein said correcting unit includes,

a detecting unit which detects whether the time difference between the synchronous timing time of the periodic control indicated by the time stamp compared by said comparing unit and the global time indicated by said second global timer at the synchronous timing indicated by said operation period timer is within an allowable range, and

does not correct said operation period timer when the time difference is outside of the allowable range.

14. The periodic control synchronous system according to claim 11, wherein said correcting unit determines the timer periodic correction value of said operation period timer by finding a value of said operation period timer at the synchronous timing of the periodic control indicated by the time stamp, or determines the timer periodic correction value of said operation period timer from the time difference between the synchronous timing time of the periodic control indicated by the time stamp and the global time

indicated by said second global timer, and thereby corrects said operation period timer based on the timer periodic correction value.

15. A periodic control synchronous system for synchronizing periodic control between controllers connected to first and second networks, and devices connected to said first network and devices connected to said second network, wherein

each of said controllers includes,

a first global timer controlled through said first network;

a second global timer controlled through said second network;

a control period timer which controls a control period of periodic control of said periodic control synchronous system;

a time stamp providing unit which provides a periodic transfer packet transmitted periodically to said first and second networks with the time stamp showing synchronous timing of the control period designated by said control period timer using global time indicated by said first and second global timers;

a first transmitting unit which transmits the periodic transfer packet provided with the time stamp to at least one of said devices connected to said first network; and

a second transmitting unit which transmits the periodic transfer packet provided with the time stamp to at least one of said devices connected to said second network, and

each of said devices connected to said first and second networks includes,

a third global timer controlled respectively through said first and second networks; and

a periodic control unit which synchronizes an operation period of the corresponding device with the control period using the synchronous timing time of the periodic control indicated by the time stamp of the periodic transfer packet transmitted by said first and second transmitting units and global time indicated by said third global timer.

16. The periodic control synchronous system according to claim 15, wherein said controller includes,

a first latch unit which latches the global time of said first global timer, and holds the time latched; and

a second latch unit which latches global time of said second global timer, and holds the time latched, wherein

said control period timer latches the global time of said first and second global timers in said first and second latch units at the synchronous timing of the periodic control designated by said control period timer, and

said time stamp providing unit provides the periodic transfer packet with the time stamp having the global time latched by said first and second latch units offset by a portion of the control period.